Supporting Information

Silver Nanowires on Carbon Nanotube Aerogel Sheets for Flexible, Transparent Electrodes

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1. Bending Test

1) preparation of AgNW/MWNT hybrid TECs on PDMS substrates

The PDMS was a prepared following a 10:1 ratio between base and hardener, degassed and cured inside an oven for 45 min at 60˚C. PDMS substrates with 1mm thickness and 1x1inch in dimension were cut and used as the flexible substrate for the TCEs.

AgNW-25 were spray-coated to 1x1 inch MWNT aerogels supported by a hollow holder following the same mechanism presented in Figure 1. The AgNW/MWNT TCEs were transferred to cured PDMS by passing the PDMS substrate through the TCE's hollow holder. Silver paste was applied to the edges of the AgNW/MWNT on PDMS for resistance measurements.

2) Bending cycle set-up and measurement of Rs(‖).

Figure S1a depict the bending cycle set-up for the AgNW/MWNT TCEs on PDMS. Three samples were subjected to 10,000 bending cycles in a compressive direction with a bending ratio of 6 mm and at a frequency of 83 cycles/min. The samples' resistances (‖) were measured with a two-point probe at 0, 10, 100, 1000 and 10,000 bending cycles. The resulting average Rs(‖) was plotted against the number of bending cycles. It was found that the average Rs(‖) for the AgNW/MWNT TCEs on PDMS was robust to bending, where after 10,000 bending cycles no significant change was noticed, Figure S1b.

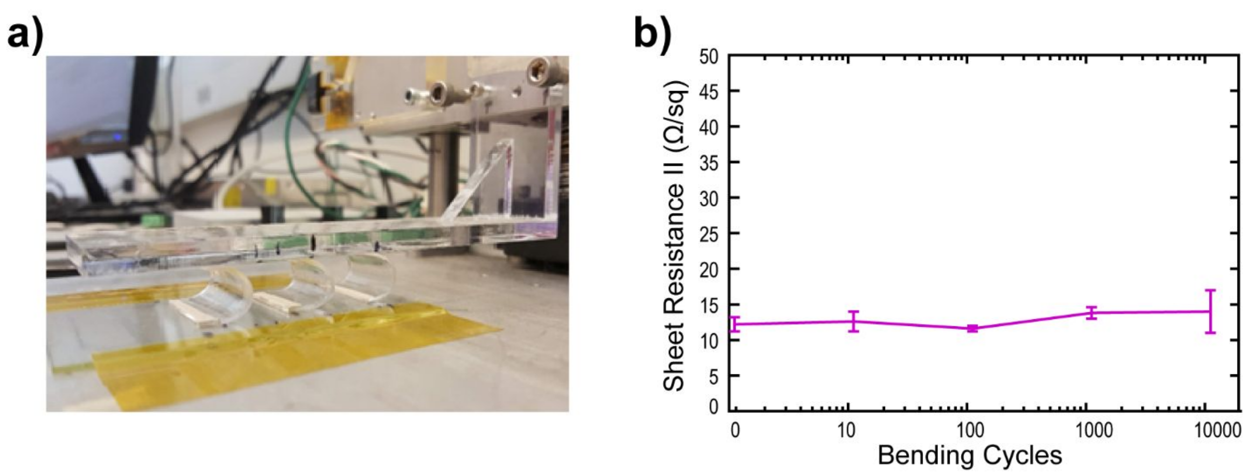

Figure S1. a) Bending test set-up for 3 AgNW/MWNT TCEs on PDMS and b) plot of the average Rs(‖) vs number on bending cycles.

2. AgNW/MWNT contact

TEM image in Figure S2a depicts AgNWs laying on top of a MWNT bundle and Figure S2b, represents the contact between a AgNW and a MWNT bundle formed by ~7 individual MWNTs.

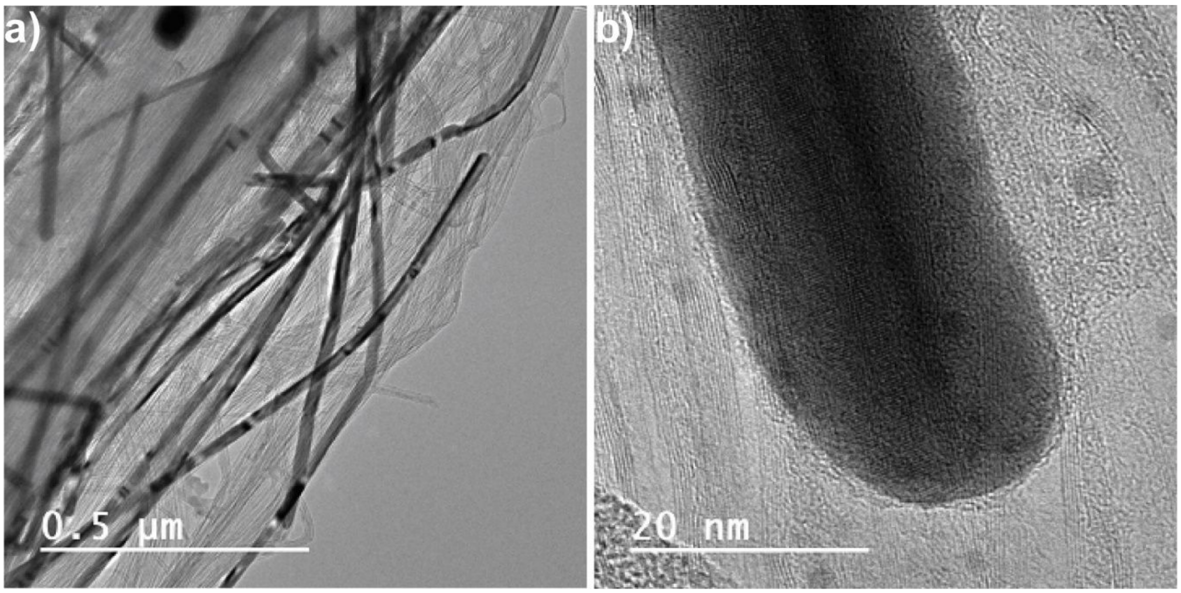

Figure S2. a-b) TEM of the AgNW/MWNT hybrid TCE. The AgNWs appear darker than the MWNTs.

3. Polyacrylonitrile (PAN) membranes spray-coated with AgNWs-25

Electrospun polyacrylonitrile (PAN) mats were placed in a 1x1 inch hollow holder and spray-coated with 0.25 mg/ml AgNWs-25 following the same procedure as for MWNTs aerogels, Figure 1a-f. The AgNW/PAN hybrid had a final Rs of ~ 1000 Ω/sq and a transmittance of 45% at 550 nm. SEM images in Figure S3a-d, show PAN fibers wrapped and connected with the AgNWs network. AgNWs filled the PAN primary of pores in the absence of PAN's densification effect when in contact with IPA.

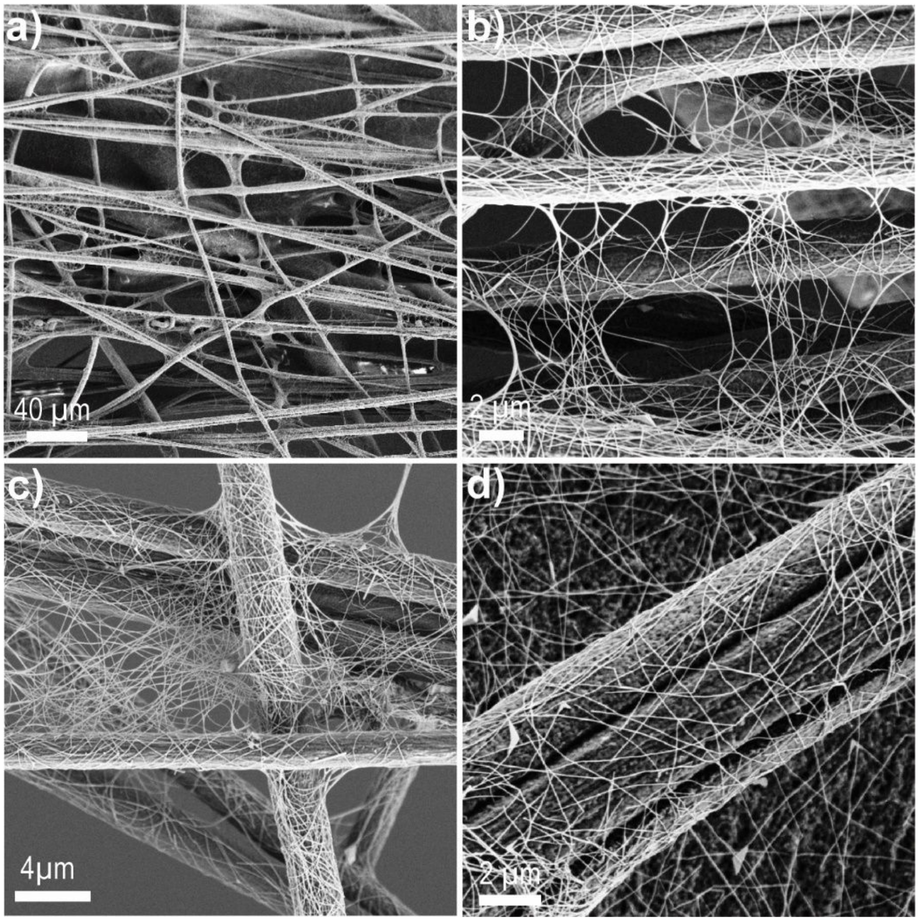

Figure S3. a-c) SEM images of PAN fibers wrapped and connected by the AgNW-25 network. d) a single PAN fiber wrapped with AgNW-25.

4. Thermal Annealing Effect

Figure S4a-b depicts SEM images of AgNWs-AgNWs contact points welded when the annealing temperature is set at 160˚C for 1-2 minutes. Fragmentation of AgNWs occurs when the AgNW/MWNT hybrid TCEs are thermally annealed at temperatures >160˚C or annealed at times > 2 minutes. The SEM imaging from Figure S4c, corresponds to a AgNW/MWNT TCE sample thermally annealed at the ideal temperature of 160˚C to but at 5 minutes rather than 1 minute. The result is partial fragmentation of the AgNWs. AgNWs disintegrate into Ag droplets when the AgNW/MWNT TCs are thermally annealed at 200˚C for 1 minute, as seen in Figure S4d.

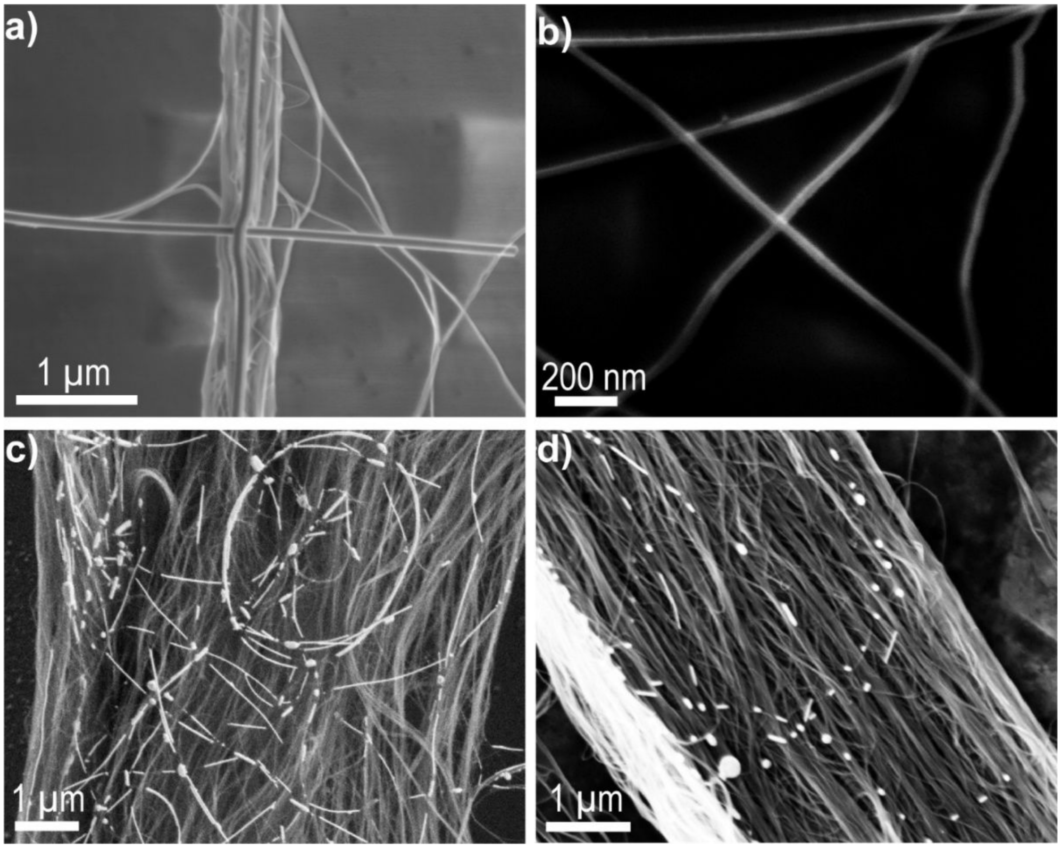

Figure S4. a-b) SEM images of AgNWs welded to one another when the annealing temperature is 160˚C and the annealing time is1-2 minutes. c) SEM imaging of a AgNW/MWNT hybrid TCE thermally annealed at 160˚C for 5 minutes and at d) 200˚C for 1 minute.

5. AgNWs dimension effect

Figure S5a-d, f are SEM images of the connections formed between the three different types of AgNWs used in this work and MWNT bundles. S5a depicts AgNWs-25 with diameters ~22 nm and lengths ~18 µm forming bridges between adjacent MWNT bundles and S5b is a closeup of a MWNT bundle being wrapped by these AgNWs-25. Figure S5c, represents AgNWs-60 with diameters ≥ 40 nm and lengths < 10 µm establishing few bridges between adjacent MWNT bundles and when these AgNWs agglomerate between neighbor MWNT bundles to form stablished bridges, Figure S5d. Bridges formed by AgNWs-130 with lengths ≥ 18 µm and diameters ≥ 40 nm are depicted in figure S5e-f. These AgNWs do not wrap around MWNT bundles but are long enough that a single AgNW can span over two MWNT bundles

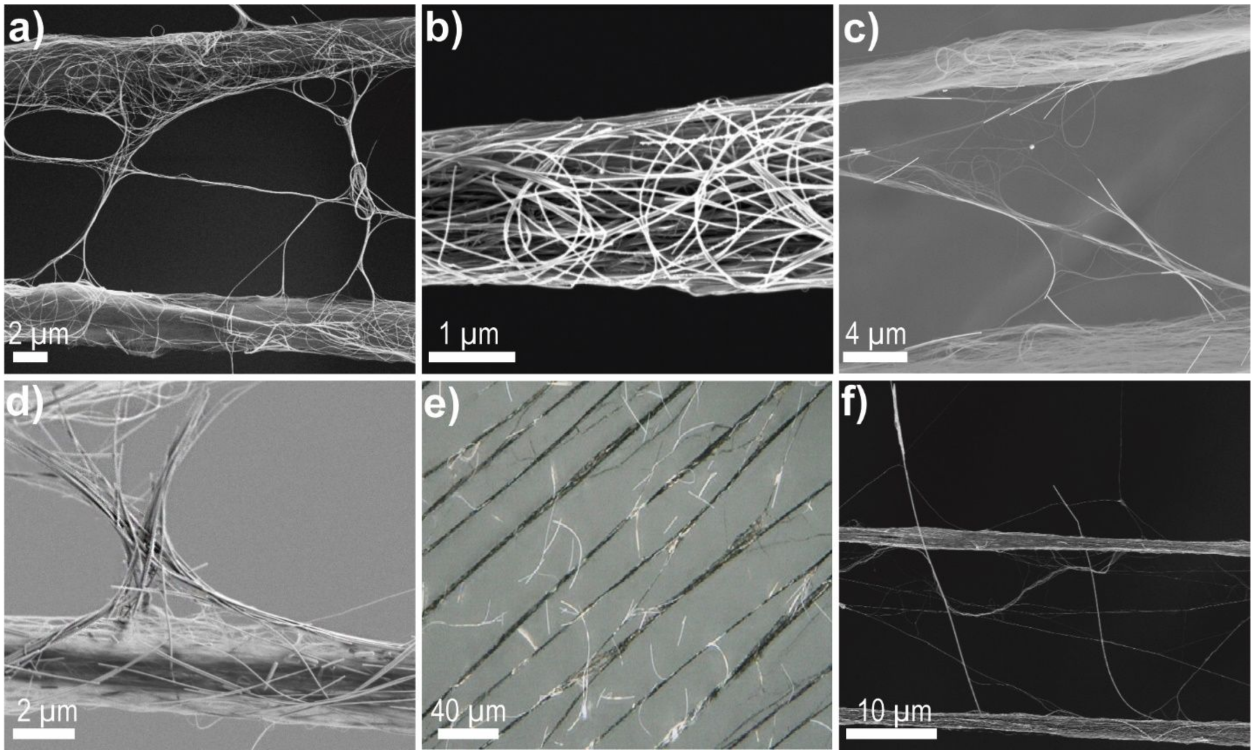

Figure S5. SEM of bridges formed between adjacent MWNT bundles of a) AgNWs-25 with diameters ~22 nm and lengths ~18 µm forming and b) MWNT bundle wrapped by these AgNWs. c) SEM of AgNWs-60 with diameters ≥ 40 nm and lengths < 10 µm) establishing few bridges between adjacent MWNT bundles and d) AgNWs agglomerated between neighbor MWNT bridges. e) Optical image of AgNWs-130 with lengths ≥ 18 µm and diameters ≥ 40 nm forming bridges between adjacent MWNT bundles and f) SEM of the same AgNWs connecting two MWNT bundles.